

Atlantic General Relativity and Cosmology Meeting

Nicholson Hall Annex
(Building 10 on campus map)
Room 23 A
Saturday, October 27, 2007
St. Francis Xavier University
Antigonish, NS

Schedule of Events and Talks

Chair: Johan Brannlund

12:30 – 1:00 Light Lunch

1:00 – 2:00 Invited Lecturer: Frans Pretorius (Princeton University)

2:00 – 2:20 Contributed talk: Nicos Pelavas (Dalhousie University)

2:20 – 2:40 Contributed talk: Georgios Papadopoulos (Dalhousie University)

2:40 – 3:00 Coffee

3:00 – 4:00 Invited Lecturer: Woei Chet Lim (Princeton University)

4:20 – 4:50 Contributed talk: Robert van den Hoogen (St. FXU)

4:50 – 5:20 Contributed talk: Sigbjorn Hervik (Dalhousie University)

5:30 – 6:30 Check in Hotel (Claymore Hotel on Church Street)

6:30 – 9:00 Banquet at the Alcove

Sponsored by: Atlantic Association for Researchers in the Mathematical Sciences
Office of the Dean of Science, St. Francis Xavier University



Abstracts

Frans Pretorius

Simulations of Binary Black Hole Coalescence

The collision of two black holes is thought to be one of the most energetic events in the universe, emitting in gravitational waves as much as 5-10% of the rest mass energy of the system. An international effort is currently underway to detect gravitational waves from black hole collisions and other cataclysmic events in the universe.

The early success of the detectors will rely on the matched filtering technique to extract what are, by the time the waves reach earth, very weak distortions in the local geometry of space and time. In the case of black hole mergers numerical simulations are needed to obtain predictions of waveforms during the final stages of coalescence. 2005 was a watershed year for numerical simulations of black holes, and we are now beginning to explore the fascinating landscape of black hole collisions in the fully non-linear regime of Einstein's theory.

In this talk I will give an overview of the recent successes and what we have learned about the merger process, for both astrophysically relevant binaries and, time permitting, more esoteric configurations. The latter include hyperbolic encounters fine-tuned to an approximate threshold of merger, exhibiting behavior similar to "zoom-whirl" geodesics in a black hole background. These types of orbits may have some relevance to speculative black hole formation by parton collisions at the LHC in large extra dimension scenarios.

Woei Chet Lim

Spikes -- nonlocal component of the billiard attractor

By applying a standard solution-generating transformation to an arbitrary vacuum Bianchi type II solution, one generates a new solution with spikes commonly observed in numerical simulations. It is conjectured that the spike solution is part of the generalized Mixmaster/billiard attractor.

Robert van den Hoogen

Spherically Symmetric Solutions in Macroscopic Gravity

Schwarzschild's solution to the Einstein Field Equations was one of the first and most important solutions that lead to the understanding and important experimental tests of Einstein's theory of General Relativity. However, Schwarzschild's solution is essentially based on an ideal theory of gravitation, where all inhomogeneities are ignored. Therefore, any generalization of the Schwarzschild solution should take into account the

effects of small perturbations that may be present in the gravitational field. Macroscopic Gravity as developed by R. Zalaletdinov does just that: it determines the effects of the inhomogeneities through a non-perturbative and covariant averaging procedure. With similar assumptions on the geometry and matter content, a solution to the averaged field equations as dictated by Zalaletdinov's Macroscopic Gravity are derived. The resulting solution provides a possible explanation for the flattening of galactic rotation curves, illustrating that Dark Matter is not real but may only be the result of averaging inhomogeneities in a spherically symmetric background.

Georgios Papadopolous

Essential and Spurious Constants

"The problem of distinguishing between essential and spurious (i.e., absorbable) constants contained in a metric tensor field in a (semi)Riemannian geometry is treated. A sufficient and necessary criterion, in terms of a covariant statement, which enables one to determine whether a constant is essential or not is presented. It turns out that the problem of characterization is, thus, reduced to that of solving a system of partial differential equations of the first order. The entire analysis is purely of local character."

Nicos Pelavas

The Karlhede bound in relativity (collaboration with R. Milson)

Abstract: The equivalence problem for differentiable manifolds is to determine when two metrics are equivalent under a general coordinate transformation. This problem was solved by Cartan and later adapted to general relativity by Karlhede. I shall briefly present Cartan's viewpoint towards this problem by discussing it in the context of the frame bundle over a spacetime and the meaning of the Cartan invariants that arise. Subsequently, I shall describe the Karlhede algorithm and the upper bound on the number covariant derivatives of Riemann that are, in principle, required to characterize a metric locally. Lastly, I shall present a recently found class of second order curvature homogeneous spacetimes that attain this upper bound.

Sigbjorn Hervik

4D CSIs

Abstract:

In this talk I am going to consider 4D spacetimes having constant curvature invariants. I am going to discuss some conjectures aiming to determine all such spacetimes. Furthermore, I will outline a proof of a theorem which states that: If a 4D CSI spacetime is of Ricci type I or of Petrov type I, then the spacetime is locally homogeneous.

Conference Report – November 2007

The workshop, originally scheduled to take place in Cape Breton, had to be re-located at the last minute due to unforeseen technical difficulties at the proposed conference facilities in Mabou. Fortunately, enough notice was given that new arrangements could be made to hold the entire workshop in Antigonish instead. The conference was supported by both the Office of the Dean of Science at St. Francis Xavier University and AARMS in the amount of \$3000. Due to the change in venue, and decreased costs associated with the change in venue, no registration fees were requested. The contribution from AARMS will cover the costs associated with bringing in a speaker, and the travel expenses of the students and Post-Doctoral Fellows who participated in the conference. The total support required from AARMS is now only \$1596.36 with the remaining costs covered by the Office of the Dean of Science at StFX in the amount of \$658.96

There were two invited speakers from Princeton University who gave exciting talks on very different problems in General Relativity. Both talks generated much discussion during the coffee break and afterwards during the banquet. The contributed speakers all presented some extremely new and exciting results in differential geometry, general relativity and/or gravitational theory.

There were 16 participants, mostly from Dalhousie University, but there were individuals from University of Alberta, University of Waterloo, Princeton University, and of course St. Francis Xavier University. In attendance were 4 faculty members, 5 Post-doctoral Fellows, 6 graduate students, and 1 other.

Conference Costs -- Atlantic General Relativity and Cosmology Conference

Frans Pretorius			
	Air	\$ 377.52	USD
	Taxi (airport to city hotel)	\$ 60.00	CAD
	Quality Inn (Halifax Airport) October 28	\$ 156.97	CAD
		\$ 594.49	AARMS
Woei Chet Lim			
	Air	\$ 370.74	USD
	Train	\$ 22.25	USD
	Train	\$ 14.00	USD
	Taxi	\$ 25.00	CAD
		\$ 431.99	Dean of Science STFX
Alan Coley			
	Garden South Park Inn (for Frans) October 26	\$ 110.69	CAD AARMS
	Garden South Park Inn (for Woei Chet) October 26	\$ 110.69	CAD Dean of Science STFX
		\$ 221.38	
Research Account (92169)			
	Sodexho Lunch	\$ 177.00	
	Sodexho Coffee	\$ 42.80	
		\$ 219.80	AARMS
Robert van den Hoogen			
	Claymore Inn (for Frans) October 27	\$ 110.58	AARMS
	Claymore Inn (for Woei Chet) October 27	\$ 116.28	Dean of Science STFX
	Claymore Inn (for Post docs) October 27	\$ 116.28	AARMS
	Claymore Inn (for grad Students) October 27	\$ 116.28	AARMS
	Banquet Meal (for all speakers, students etc.)	\$ 328.24	AARMS
		\$ 787.66	
	TOTAL EXPENDITURES	\$ 2,255.32	
	TOTAL cost to DEAN of SCIENCE STFX	\$ 658.96	
	TOTAL cost to AARMS	\$ 1,596.36	